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THE MONIST.

ON THE PART PLAYED BY ACCIDENT IN INVENTION AND DISCOVERY.[1]

IT is characteristic of the naïve and sanguine beginnings of thought in youthful men and nations, that all problems are held to be soluble and fundamentally intelligible on the first appearance of success. The sage of Miletus, on seeing the plant take its rise from moisture, believed he had comprehended the whole of nature, and he of Samos, on discovering that definite numbers corresponded to the lengths of harmonical strings, imagined he could exhaust the nature of the world by means of numbers. Philosophy and science in such periods are blended. Wider experience, however, speedily discloses the error of this course, gives rise to criticism, and leads to the division and ramification of the sciences.

At the same time, the necessity of a broad and general view of the world remains; and to meet this need philosophy parts company with special inquiry. It is true, the two are often found united in gigantic personalities. But as a rule their ways diverge more and more widely from each other. And if the estrangement of philosophy from science can reach a point where data unworthy of the nursery are deemed none too scanty as foundations of the world, on the other hand the thorough-paced specialist may go to the extreme

[1] Inaugural lecture delivered on assuming the Professorship of the History and Theory of Inductive Science in the University of Vienna, October 20, 1895. (Unpublished.) Translated by Thomas J. McCormack.

of rejecting point-blank the possibility of a broader view, or at least of deeming it superfluous, forgetful of Voltaire's apophthegm, nowhere more applicable than here, *Le superflu—chose très nécessaire.*

It is true, the history of philosophy, owing to the insufficiency of its constructive data, is and must be largely a history of error. But it would be the height of ingratitude on our part to forget that the seeds of thoughts which still fructify the soil of special research, such as the theory of irrationals, the conceptions of conservation, the doctrine of evolution, the idea of the specific energies, and so forth, may be traced back in distant ages to philosophical sources. Furthermore, to have deferred or abandoned the attempt at a broad philosophical view of the world from a full knowledge of the insufficiency of our materials, is quite a different thing from never having undertaken it at all. The revenge of its neglect, moreover, is constantly visited upon the specialist by his committal of the very errors which philosophy long ago disclosed. As a fact, in physics and physiology, particularly during the first half of this century, are to be met intellectual productions which for naïve simplicity yield not an iota to those of the Ionian school, or to the Platonic ideas, or to that much reviled ontological proof.

Latterly, there has been evidence of a gradual change in this state of affairs. Recent philosophy has set itself more modest and more attainable ends; she is no longer inimical to special inquiry; in fact, she is zealously taking a part in that inquiry. On the other hand, the special sciences, mathematics and physics, no less than philology, have become eminently philosophical. The material presented is no longer accepted uncritically. The glance of the inquirer is bent to the neighboring fields, whence that material has been derived. The different special departments are striving for closer union, and gradually the conviction is gaining ground that philosophy can consist only of mutual, complemental criticism, interpenetration, and union of the special sciences into a consolidated whole. As the blood in nourishing the body separates into countless capillaries, only to be collected again and to meet in the heart, so in the science of the future all the rills of knowledge will be gathered more and more into a common and undivided stream.

It is this view—not an unfamiliar one to the present generation—that I purpose to advocate. Cherish no hope, or rather have no fear, that I shall erect systems for you. I shall remain a natural inquirer. Nor expect that it is my intention to skirt all the fields of natural inquiry. I can attempt to be your guide only in that branch which is familiar to me, and even there I can assist in the furtherment of only a small portion of the allotted task. If I shall succeed in rendering plain to you the relations of physics, psychology, and the theory of knowledge, so that you may draw from each of them profit and light, redounding to each, I shall regard my work as not having been in vain. Therefore, to illustrate by an example how, consonantly with my powers and views, I conceive such inquiries should be conducted, I shall treat to-day, in the form of a brief sketch, of the following special and limited subject—of *the part which accidental circumstances play in the development of inventions and discoveries.*

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When we Germans say of a man that he was not the inventor of gunpowder,[1] we impliedly cast a grave suspicion on his abilities. But the expression is not a felicitous one, as there is probably no invention in which deliberate thought had a smaller, and pure luck a larger, share than in this. It is well to ask, Are we justified in placing a low estimate on the achievement of an inventor because accident has assisted him in his work? Huygens, whose discoveries and inventions are justly sufficient to entitle him to an opinion in such matters, lays great emphasis on this factor. He asserts that a man capable of inventing the telescope without the concurrence of accident must have been gifted with superhuman genius.[2]

A man living in the midst of civilisation finds himself surrounded by a host of marvellous inventions, considering none other than the means of satisfying the needs of every-day life. Picture such

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[1] The phrase is, *Er hat das Pulver nicht erfunden.*

[2] "Quod si quis tanta industria exstitisset, ut ex naturae principiis et geometria hanc rem eruere potuisset, eum ego supra mortalium sortem ingenio valuisse dicendum crederem. Sed hoc tantum abest, ut fortuito reperti artificii rationem non adhuc satis explicari potuerint viri doctissimi."—Hugenii Dioptrica (de telescopiis).

a man transported to the epoch preceding the invention of these ingenious appliances, and imagine him undertaking in a serious manner to comprehend their origin. At first the intellectual power of the men capable of producing such marvels will strike him as incredible, or, if we adopt the ancient view, as divine. But his astonishment is considerably allayed by the disenchanting yet elucidative revelations of the history of primitive culture, which to a large extent prove that these inventions took their rise very slowly and by imperceptible degrees.

A small hole in the ground with fire kindled in it constituted the primitive stove. The flesh of the quarry, wrapped with water in its skin, was boiled by contact with heated stones. Cooking by stones was also performed in wooden vessels. Hollow gourds were protected from the fire by coats of clay. Thus, from the burned clay accidentally originated the enveloping pot, which rendered the gourd superfluous, although for a long time thereafter the clay was still spread over the gourd, or pressed into woven wicker-work, before the potter's art assumed its final independence. Even then the wicker-work ornament was retained, as a sort of attest of its origin.

We see, thus, it is by accidental circumstances, that is, by such as lie without his purpose, foresight, and power, that man is gradually led to the acquaintance of improved means of satisfying his wants. Let the reader picture to himself the genius of a man who could have foreseen without the help of accident that clay handled in the ordinary manner would produce a useful cooking utensil! The majority of the inventions made in the early stages of civilisation, including language, writing, money, and the rest, could not have been the product of deliberate methodical reflexion for the simple reason that no idea of their value and significance could have been had except from their practical use. The invention of the bridge may have been suggested by the trunk of a tree which had fallen athwart a mountain-torrent; that of the tool by the use of a stone accidentally taken into the hand to crack nuts. The use of fire probably started in and was disseminated from regions where volcanic eruptions, hot springs, and burning jets of natural gas

afforded opportunity for quietly observing and turning to practical account the properties of fire. Only after that had been done could the significance of the fire-drill be appreciated, an instrument which was probably discovered by boring a hole through a piece of wood. The suggestion of a distinguished inquirer that the invention of the fire-drill originated on the occasion of a religious ceremony is both fantastic and incredible. And as to the use of fire, we should no more attempt to derive that from the invention of the fire-drill than we should from the invention of sulphur matches. Unquestionably the opposite course was the real one.[1]

Similar phenomena, though still largely veiled in obscurity, mark the initial transition of nations from a hunting to a nomadic life and to agriculture.[2] We shall not multiply examples, but content ourselves with the remark that the same phenomena recur in historical times, in the ages of great technical inventions, and, further, that regarding them the most whimsical notions have been circulated—notions which ascribe to accident an unduly exaggerated part, and one which in a psychological respect is absolutely impossible. The observation of steam escaping from a tea-kettle and of the clattering of the lid is supposed to have led to the invention of the steam-engine. Just think of the gap between this spectacle and the conception of the performance of a large amount of work by steam, for a man totally ignorant of the steam-engine! Let us suppose, however, that an engineer, versed in the practical construction of pumps, should accidentally dip into water an inverted bottle that had been filled with steam for drying and still retained its steam. He would see the water rush violently into the bottle, and the idea would very naturally suggest itself of founding on this experience a convenient and useful atmospheric steam-pump, which by imperceptible degrees, both psychologically possible and immediate, would then undergo a natural and gradual transformation into Watt's steam-engine.

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[1] I must not be understood as saying that the fire-drill has played no part in the worship of fire or of the sun.

[2] Compare on this point he extremely interesting remarks of Dr. Paul Carus in his *Philosophy of the Tool* Chicago, 1893.

But granting that the most important inventions are brought to man's notice accidentally and in ways that are beyond his foresight, yet it does not follow that accident alone is sufficient to produce an invention. The part which man plays is by no means a passive one. Even the first potter in the primeval forest must have felt some stirrings of a genius within him. In all such cases, the inventor is obliged *to take note* of the new fact, he must discover and grasp its advantageous feature, and must have the power to turn that feature to account in the realisation of his purpose. He must *distinguish* the new feature, impress it upon his memory, unite and interweave it with the rest of his thought; in short, he must possess the capacity *to profit by experience.*

The capacity to profit by experience might well be set up as a test of intelligence. That power varies considerably in men of the same race, and increases enormously as we advance from the lower animals to man. The former are limited almost entirely to the reflex actions which they have inherited with their organism, they are almost totally incapable of individual experience, and considering their simple wants are scarcely in need of it. The ivory-snail (*Eburna spirata*) never learns to avoid the carnivorous Actinia, no matter how often it may wince under the latter's shower of needles, having apparently no memory whatever for pain.[1] A spider can be lured forth repeatedly from its hole by touching its web with a tuning-fork. The moth plunges again and again into the flame which has burnt it. The humming-bird hawk-moth[2] dashes repeatedly against the painted roses of the wall-paper, like the unhappy and desperate thinker who never wearies of attacking in the same way the same insoluble chimerical problem. As aimlessly almost as Maxwell's gaseous molecules and in the same unreasoning manner common flies in their search for light and air stream against the glass pane of a half-opened window and remain there from sheer inability to find their way around the narrow frame. But

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[1] Möbius, *Naturwissenschaftlicher Verein für Schleswig-Holstein*, Kiel, 1893, p. 113 et seq.

[2] I am indebted for this observation to Professor Hatscheck.

a pike separated from the minnows of his aquarium by a glass partition, learns after the lapse of a few months, though only after having butted himself half to death, that he cannot attack these fishes with impunity. What is more, he leaves them in peace even after the removal of the partition, though he will bolt at once a strange fish. Considerable memory must be attributed to birds of passage, a memory which, probably owing to the absence of disturbing thoughts, acts with the precision of that of some idiots. Finally, the susceptibility to training evinced by the higher vertebrates is indisputable proof of the ability of these animals to profit by experience.

A powerfully developed *mechanical* memory, which recalls vividly and faithfully old situations, is sufficient for avoiding definite particular dangers, or for taking advantage of definite particular opportunities. But more is required for the development of *inventions*. More extensive chains of images are necessary here, the excitation by mutual contact of widely different trains of ideas, a more powerful, more manifold, and richer connexion of the contents of memory, a more powerful and impressionable psychical life, heightened by use. A man stands on the bank of a mountain-torrent, which is a serious obstacle to him. He remembers that he has crossed just such a torrent before on the trunk of a fallen tree. Hard by trees are growing. He has often moved the trunks of fallen trees. He has also felled trees before, and then moved them. To fell trees he has used sharp stones. He goes in search of such a stone, and as the old situations that crowd into his memory and are held there in living reality by the definite powerful interest which he has in crossing just this torrent,—as these impressions are made to pass before his mind in the *inverse order* in which they were here evoked, he invents the bridge.

There can be no doubt but the higher vertebrates adapt their actions in some moderate degree to circumstances. The fact that they give no appreciable evidence of advance by the accumulation of inventions, is satisfactorily explained by a difference of degree or intensity of intelligence as compared with man; the assumption of a difference of kind is not necessary. A person who saves a little

every day, be it ever so little, has an incalculable advantage over him who daily loses that amount, or is unable to keep what he has accumulated. A slight quantitative difference in such things explains enormous differences of advancement.

The rules which hold good in prehistoric times also hold good in historical times, and the remarks made on invention may be applied almost without modification to discovery; for the two are distinguished solely by the use to which the new knowledge is put. In both cases the investigator is concerned with some *newly observed* relation of new or old properties, abstract or concrete. It is observed, for example, that a substance which gives a chemical reaction A is also the cause of a chemical reaction B. If this observation fulfils no purpose but that of furthering the scientist's insight, or of removing a source of intellectual discomfort, we have a discovery; but an invention, if in using the substance giving the reaction A to produce the desired reaction B, we have a practical end in view, and seek to remove a cause of material discomfort. The phrase, *disclosure of the connexion of reactions*, is broad enough to cover discoveries and inventions in all departments. It embraces the Pythagorean proposition, which is a combination of a geometrical and an arithmetical reaction, Newton's discovery of the connexion of Kepler's motions with the law of the inverse squares, as perfectly as it does the detection of a small appropriate alteration in the construction of a tool, or of an appropriate change in the methods of work of a dyeing establishment.

The disclosure of new provinces of facts before unknown can only be brought about by accidental circumstances, under which are *remarked* facts that commonly go unnoticed. The achievement of the discoverer here consists in his *sharpened attention*, which detects the uncommon features of an occurrence and their determining conditions from their most evanescent marks,[1] and discovers means of submitting them to exact and full observation. Under this head belong the first disclosures of electrical and magnetic phenomena, Grimaldi's observation of interference, Arago's discovery of the in-

[1] Cf. Hoppe, *Entdecken und Finden*. 1870.

creased check suffered by a magnetic needle vibrating in a copper envelope as compared with that observed in a bandbox, Foucault's observation of the stability of the plane of vibration of a rod accidentally struck while rotating in a turning-lathe, Mayer's observation of the increased redness of venous blood in the tropics, Kirchhoff's observation of the augmentation of the *D*-line in the solar spectrum by the interposition of a sodium lamp, Schönbein's discovery of ozone from the phosphoric smell emitted on the disruption of air by electric sparks, and a host of others. All these facts, of which unquestionably many were *seen* numbers of times before they were *noticed*, are examples of the inauguration of momentous discoveries by accidental circumstances, and place the importance of strained attention in a brilliant light.

But not only is a significant part played in the beginning of an inquiry by co-operative circumstances beyond the foresight of the investigator; their influence is also active in its prosecution. Dufay, thus, whilst following up the behavior of *one* electrical state which he had assumed, discovers the existence of *two*. Fresnel learns by accident that the interference-bands received on ground glass are seen to better advantage in the open air. The diffraction-phenomenon of two slits proved to be considerably different from what Fraunhofer had anticipated, and in following up this circumstance he was led to the important discovery of grating-spectra. Faraday's induction-phenomenon departed widely from the initial conception which occasioned his experiments, and it is precisely this deviation that constitutes his real discovery.

Every man has pondered on some subject. Every one of us can multiply the examples cited, by less illustrious ones from his own experience. I shall cite but one. On rounding a railway curve once, I accidentally remarked a striking apparent inclination of the houses and trees. I discovered from this that the direction of the total physical acceleration of a mass carries with it as its physiological reaction the perception of the vertical. Afterwards, in attempting to inquire more carefully into this phenomenon, and this only, in a large whirling machine, the collateral phenomena conducted me to the sensation of the angular acceleration, vertigo,

Flouren's experiments on the section of the circular canals, and so on, from which gradually resulted views relating to the sensations of direction which are also held by Breuer and Brown, which were at first contested on all hands, but are now regarded on many sides as correct, and which have been recently enriched by the interesting inquiries of Breuer concerning the *macula acustica*, and Kreidel's experiments with magnetically orientable crustacea. Not disregard of accident but a direct and purposeful employment of it advances research.

The more powerful the psychical connexion of the memory pictures is,—and it varies according to the individual and the mood,—the more apt is the same accidental observation to be productive of results. Galileo knows that the air has weight; he also knows of the "resistance to a vacuum," expressed both in weight and in the height of a column of water. But the two ideas dwelt asunder in his mind. It remained for Torricelli to vary the specific gravity of the liquid measuring the pressure, and not till then was the air included in the list of pressure-exerting fluids. The reversal of the lines of the spectrum was seen repeatedly before Kirchhoff, and had been mechanically explained. But it was left for his penetrating vision to discern the evidence of the connexion of this phenomenon with questions of heat, and to him alone through persistent labor was revealed the sweeping significance of the fact for the mobile equilibrium of heat. Supposing, then, that such a rich organic connexion of the elements of memory exists, and is the prime distinguishing mark of the inquirer, next in importance certainly is that *intense interest* in a definite object, in a definite idea, which fashions advantageous combinations of thought from elements before disconnected, and obtrudes that idea into every observation made, and into every thought formed, making it enter into relationship with all things. Thus Bradley, deeply engrossed with the subject of aberration, is led to its solution by an exceedingly unobtrusive experience in crossing the Thames. It is permissible, therefore, to ask whether accident leads the discoverer, or the discoverer accident, to a successful outcome in scientific quests.

No man should dream of solving a great problem unless he is

so thoroughly saturated with his subject that everything else sinks into comparative insignificance. During a hurried meeting with Mayer in Heidelberg once, Jolly remarked, with a rather dubious implication, that if Mayer's theory were correct water could be warmed by shaking. Mayer went away without a word of reply. Several weeks later, and now unrecognised by Jolly, he rushed into the latter's presence exclaiming: "Es ischt aso!" (It is so, it is so!). It was only after considerable explanation that Jolly found out what Mayer wanted to say. The incident needs no comment.[1]

A person deadened to sensory impressions and given up solely to the pursuit of his thoughts, also can light on an idea that will divert his mental activity into totally new channels. In such cases it is a psychical accident, an intellectual experience, as distinguished from a physical accident, to which the person owes his discovery—a discovery which is here made "deductively" by means of mental copies of the world, instead of experimentally. *Purely* experimental inquiry, moreover, does not exist, for, as Gauss says, virtually we always experiment with our thoughts. And it is precisely that constant, corrective interchange or intimate union of experiment and deduction, as it was cultivated by Galileo in his *Dialogues* and by Newton in his *Optics*, that is the foundation of the benign fruitfulness of modern scientific inquiry as contrasted with that of antiquity, where observation and reflexion ofttimes pursued their several courses like two strangers.

We have to wait for the appearance of a favorable physical accident. The movement of our thoughts obeys the law of association. In the case of meagre experience the result of this law is simply the mechanical reproduction of definite sensory experiences. On the other hand, if the psychical life is subjected to the incessant influences of a powerful and rich experience, then every representative element in the mind is connected with so many others that the actual and natural course of the thoughts is easily influenced and determined by insignificant circumstances, which accidentally are decisive. Hereupon, the process termed imagination produces

[1] This story was related to me by Jolly, and subsequently repeated in a letter from him.

its protean and infinitely diversified forms. Now what can we do to guide this process, seeing that the combinatory law of the images is without our reach? Rather let us ask, what influence can a powerful and constantly recurring idea exert on the movement of our thoughts? According to what has preceded, the answer is involved in the question itself. The *idea* dominates the thought of the inquirer, not the latter the former.

Let us see, now, if we can acquire a profounder insight into the process of discovery. The condition of the discoverer is, as James has aptly remarked, not unlike the situation of a person who is trying to remember something that he has forgotten. Both are sensible of a gap, and have only a remote presentiment of what is missing. Suppose I meet in company a well-known and affable gentleman whose name I have forgotten, and who to my horror asks to be introduced to someone. I set to work according to Lichtenberg's rule, and run down the alphabet in search of the initial letter of his name. A vague sympathy holds me at the letter *G*. Tentatively I add the second letter and am arrested at *e*, and long before I have tried the third letter *r*, the name "Gerson" breaks sonorously upon my ear, and my anguish is gone. While taking a walk I meet a gentleman from whom I receive a communication. On returning home, and in attending to weightier affairs, the matter slips my mind. Moodily, but in vain, I ransack my memory. Finally I observe that I am going over my walk in thought. On the street corner in question the gentleman again stands before me and repeats his communication. In this process are recalled successively to consciousness all the percepts which were connected with the percept that was lost, and with them, finally, that, too, is brought to light. In the first case—where the experience had already been made and is permanently impressed on our thought—a *systematic* procedure is both possible and easy, for we know that a name must be composed of a limited number of sounds. But at the same time it should be observed that the labor involved in such a combinatorial task would be enormous if the name were long and the responsiveness of the mind weaker.

It is often said, and not wholly without justification, that the

scientist has solved a *riddle*. Every problem in geometry may be clothed in the garb of a riddle. Thus: "What thing is that M which has the properties A, B, C?" "What circle is that which touches the straight lines A, B, touching B in the point C?" The first two conditions marshal before the imagination the group of circles whose centres lie in the line of symmetry of A, B. The third condition reminds us of all the circles having centres in the straight line which stands at right angles to B in C. The *common* term, or common terms, of these groups of images solve the riddle—satisfy the problem. Puzzles dealing with things or words induce similar processes, but the memory in such cases is exerted in many directions and more varied and less clearly ordered provinces of ideas have to be surveyed. The difference between the situation of a geometer who has a construction to make, and that of an engineer, or a scientist, confronted with a problem, is simply this, that the first moves in a field with which he is thoroughly acquainted, whereas the two latter are obliged to familiarise themselves with this field subsequently, and in a measure far transcending what is commonly required. In this process the mechanical engineer has at least always a definite goal before him and definite means to accomplish his aim, whilst in the case of the scientist that aim is in many instances presented only in vague and general outlines. Often the very formulation of the riddle devolves on him. Frequently it is not until the aim has been reached that the broader outlook requisite for systematic procedure is obtained. By far the larger portion of his success, therefore, is contingent on luck and instinct. It is immaterial, so far as its character is concerned, whether the process in question is brought rapidly to a conclusion in the brain of one man, or whether it is spun out for centuries in the minds of a long succession of thinkers. The same relation that a word solving a riddle bears to that riddle is borne by the modern conception of light to the facts discovered by Grimaldi, Römer, Huygens, Newton, Young, Malus, and Fresnel, and only by the help of this slowly developed conception is our mental vision enabled to embrace the broad domain of facts in question.

A welcome complement to the discoveries which the history of

civilisation and comparative psychology have furnished, is to be found in the confessions of great scientists and artists. Scientists *and* artists, we might say, for Liebig courageously declared there was no essential difference between the labors of the two. Are we to regard Leonardo da Vinci as a scientist or as an artist? If it is the business of the artist to build up his work from a few motives, it is the task of the scientist to discover the motives which permeate reality. If scientists like Lagrange or Fourier are in a certain measure artists in the presentation of their results, on the other hand, artists like Shakespeare or Ruysdael are scientists in the insight which must have preceded their creations.

Newton, when questioned about his methods of work, could give no other answer but that he was wont to ponder again and again on a subject; and similar utterances are accredited to D'Alembert and Helmholtz. Scientists and artists both recommend persistent labor. After the repeated survey of a field has afforded opportunity for the interposition of advantageous accidents, has rendered all the traits that suit with the mood or the dominant thought more vivid, and has gradually relegated to the background all things that are inappropriate, making their future appearance impossible; then from the teeming, swelling host of fancies which a free and high-flown imagination calls forth, suddenly that particular form arises to the light which harmonises perfectly with the ruling idea, mood, or design. Then it is that that which has resulted slowly as the result of a gradual selection, appears as if it were the outcome of a deliberate act of creation. Thus are to be explained the statements of Newton, Mozart, Richard Wagner, and others, when they say that thoughts, melodies, and harmonies had poured in upon them, and that they had simply retained the right ones. Undoubtedly, the man of genius, too, consciously or instinctively, pursues systematic methods, wherever it is possible; but in his delicate presentiment he will omit many a task or abandon it after a hasty trial on which a less endowed man would squander in vain his energies. Thus, the genius accomplishes[1] in a brief space of

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[1] I do not know whether Swift's academy of schemers in Lagado, in which great discoveries and inventions were made by a sort of verbal game of dice, was in-

time undertakings for which the life of an ordinary man would far from suffice. We shall hardly go astray if we regard genius as only a slight deviation from the average mental endowment—as possessing simply a greater sensitiveness of cerebral reaction and a greater swiftness of reaction. The men who, obeying their inner impulses, make sacrifices for an idea instead of advancing their material welfare, may appear to the full-blooded Philistine as fools; yet we shall scarcely adopt Lombroso's view, that genius is to be regarded as a disease, although it is unfortunately true that a more sensitive brain, a more fragile constitution, succumbs far more readily to sickness.

The remark of C. G. J. Jacobi that mathematics is slow of growth and only reaches the truth by long and devious paths, that the way to its discovery must be prepared for long beforehand, and that then the truth will make its long-deferred appearance as if impelled by some divine necessity[1]—all this holds true of every science. We are astounded often to note that it required the combined labors of many eminent thinkers for a full century to reach a truth which it takes us only a few hours to master and which once acquired seems extremely easy to reach under the right sort of circumstances. To our humiliation we learn that even the greatest men are born more for life than for science. The extent to which even they are indebted to accident—to that singular conflux of the physical and the psychical life in which the continuous but yet imperfect and never-ending adaptation of the latter to the former finds its distinct expression—that has been the subject of our remarks to-day. Jacobi's poetical thought of a divine necessity acting in science will lose none of its loftiness for us if we discover in this necessity the same power that destroys the unfit and fosters the fit. For loftier, nobler, and more romantic than poetry is the truth and the reality.

VIENNA. E. MACH.

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tended as a satire on Francis Bacon's method of making discoveries by means of huge synoptic tables constructed by scribes. It certainly would not have been ill-placed.

[1] The original passage in Latin is quoted by Simony, *In ein ringförmiges Band einen Knoten zu machen*, Vienna, 1881, p. 41.